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# A TEN-KEY TYPEWRITER

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ABSTRACT: A typewriter utilizing only ten keys, one for each finger, is described. The required number of symbols is achieved by allowing two or more keys to be pressed simultaneously. Learning curves for two subjects are given for a particular coding of letters.

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# A TEN-KEY TYPEWRITER

The only important change made in typewriter keyboards in more than 50 years has been a reduction of the work required to operate the keys. Several suggestions have been made concerning improved location of the various symbols on the keys, but none of these changes has demonstrated enough improvement in performance to warrant a changeover from the standard keyboard. The research described here inquires into two aspects of a radically new typewriter keyboard using only ten keys. First, with what speed and accuracy can a person type with a ten-key keyboard which uses multiple key depressions to obtain the required number of symbols? Second, how long does it take to learn to type whole words from a single press of multiple-key patterns on this keyboard? The first of these questions is answered in the present memorandum.

It is very unlikely that a multiple-press keyboard will be superior in speed to the usual 44-key keyboard if both keyboards are capable of printing only one letter at a time. This prediction stems from the fact that a skilled typist hits keys at just about the maximum tapping rate for the finger (in the neighborhood of ten per second). There also is no reason to believe that the multiple-press keyboard would be significantly better in accuracy. There are, however, potential advantages of the multiple-press keyboard which warrant its study. The most important of these advantages is that many more symbols are capable of being coded into single responses than are possible with a one-at-a-time key machine. A ten-key multiple-press keyboard is capable of 1023 different patterns, thus it has an impressive capacity for use with a word-writing typewriter.

## Apparatus

Ten keys activating electrical switches were arranged in two arcs so as to fit comfortably under the ten fingers of the subject's hands (Figure 1). A specially designed keyboard was built with a total key travel of 1/8 inch and an operating force of 90-110 grams. The force required to hold the key in the operated position was 50-60 grams. The operating characteristics of the keys were thus not unlike a new IBM electric typewriter.

Since the typist cannot press two keys at exactly the same time, a delay circuit was incorporated such that any key pressed within .03 second of the first key pressed would be included as a simultaneous pattern.

The keyboard was connected through appropriate relay circuitry to an IBM receiving typewriter fitted with upper case letters only. The left thumb key operated the space bar, the right thumb key operated the carriage return and the eight finger keys operated the 26 letters, period and

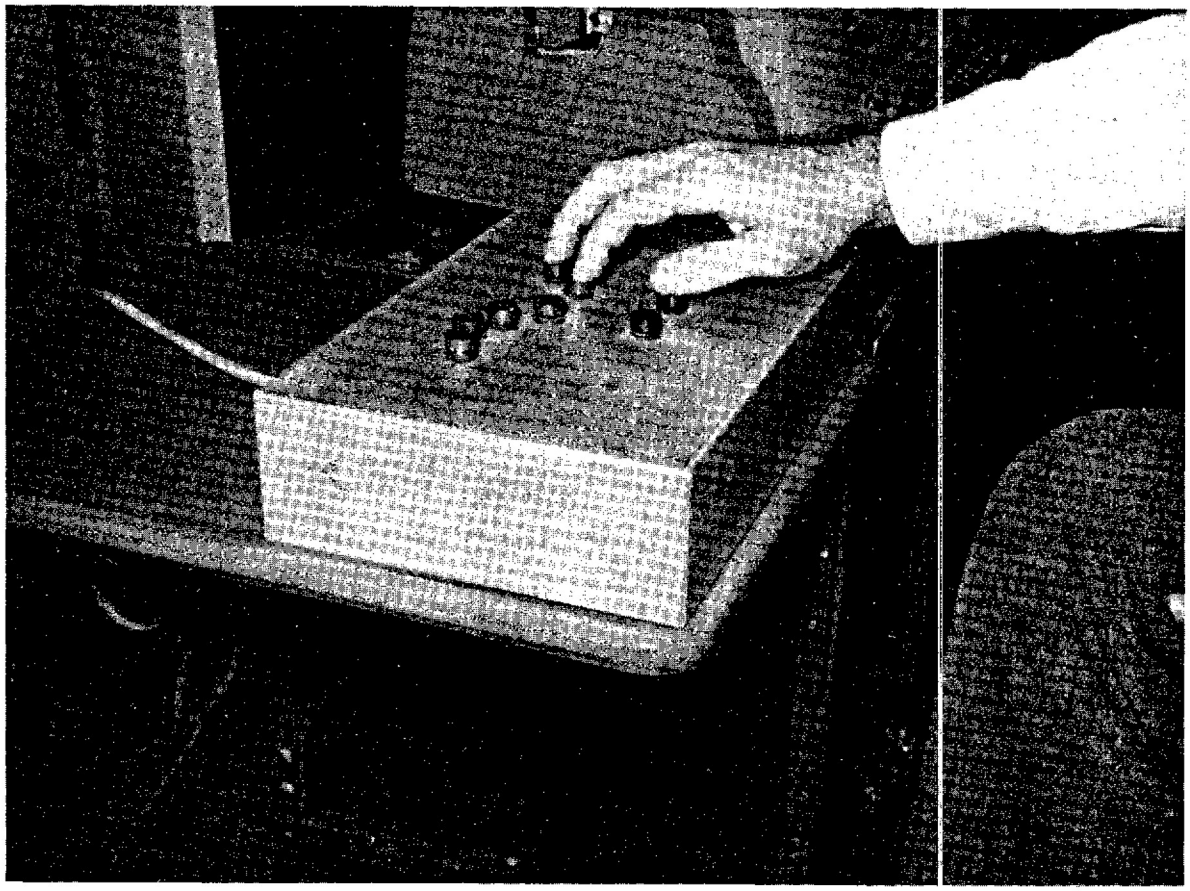

Figure 1 - Ten-key keyboard shown with subject's right hand only in position. Placement of keys for right and left hands is symmetrical.

comma according to the code shown in Table I. The coding was chosen to give the eight most frequent letters in English single key codes and the other 18 letters, two-key codes.

The ten-key keyboard and receiving typewriter were placed in the same room so the subject could hear the end-of-line bell and check the typed copy at will.

## Subjects

Two undergraduate college students served as paid subjects. One (JT) was skilled in touch typing on a conventional keyboard and the other (RB) had very little experience with the conventional typewriter.

## Procedure

The subjects were given a copy of the code shown in Table I and instructed to practice the sentence "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG" until they could type it without reference to the code sheet. Both subjects accomplished this within three fifty-minute periods.

After learning the code, the subjects were given a list of the 1000 most frequent words in English. These words were randomly ordered and divided into groups of 60 words each (a few words were repeated to make up the last group). The words were printed out in single columns from IBM cards on the 402 printer.

The subjects typed each group of 60 words once before repeating any group. Time to type each group was recorded to the nearest tenth of a minute. During this phase of training the emphasis was entirely on speed development with little concern for errors. The slower subject (JT) typed through the set of 1000 words 12 times, the faster subject (RB), 19 times. This took about twelve weeks with three fifty-minute sessions per week.

After the twelve weeks on the random words the subjects were given English text to type. Samples of text containing approximately 670 strokes each were typed and timed. The subjects were informed about their work-per-minute scores and errors after each session and were instructed how to work for accuracy first and speed second. The text tests were given over a three week period with three fifty-minute sessions per week.

The total time spent with the ten-key typewriter for the random words was approximately 30 hours. Typing text consumed about 6 additional hours.

## TABLE I

## TEN-KEY CODING USED IN THIS STUDY

| | Left Hand | | | | | Right Hand | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 3 | 2 | 1 | T | T | 1 | 2 | 3 | 4 |
| Space | | | | | | ⊗ | | | | |
| Carriage Return | | | | | ⊗ | | | | | |
| Period | | | ⊗ | | | | | | ⊗ | |
| Comma | | ⊗ | | | | | | ⊗ | | |
| Letter | | | | | | | | | | |
| A | | | ⊗ | | | | | | | |
| B | | | | ⊗ | | | | ⊗ | | |
| C | | ⊗ | ⊗ | | | | | | | |
| D | | | | | | | | ⊗ | ⊗ | |
| E | | | | | | | ⊗ | | | |
| F | ⊗ | | | ⊗ | | | | | | |
| G | | | | | | | ⊗ | | ⊗ | |
| H | | | | | | | ⊗ | ⊗ | | |
| I | ⊗ | | | | | | | | | |
| J | | | ⊗ | | | | | | | ⊗ |
| K | | | | ⊗ | | | | | | ⊗ |
| L | | | ⊗ | ⊗ | | | | | | |
| M | | | | | | | | ⊗ | | ⊗ |
| N | | | | | | | | | ⊗ | |
| O | | | | | | | | ⊗ | | |
| P | ⊗ | | ⊗ | | | | | | | |
| Q | ⊗ | | | | | | | ⊗ | | |
| R | | ⊗ | | | | | | | | |
| S | | | | | | | | | | ⊗ |
| T | | | | ⊗ | | | | | | |
| U | | | | | | | ⊗ | | | ⊗ |
| V | | | ⊗ | | | | ⊗ | | | |
| W | | | | ⊗ | | | ⊗ | | | |
| X | | ⊗ | | | | | ⊗ | | | |
| Y | | | ⊗ | | | | | ⊗ | | |
| Z | ⊗ | | | | | | ⊗ | | | |

## Results

Improvement with practice in terms of gross "words" per minute typed is shown in Figure 2. For measures of typing speed, "words" are defined as the usual five-character group with space counted as a character. The better subject (RB) typed through the first 1020 random words at an average speed of 20 wpm and progressed to a gross speed of 60 wpm after the 30 hours of training. The other subject (JT) started at 17 wpm and reached 37 wpm after training on the random words. The change to text was accompanied by greater emphasis on accuracy so that gross speed fell for both subjects while the errors also decreased.

Accuracy in terms of percentage of strokes wrong is given for each point in Figure 2. Because there was no emphasis on accuracy during the random-word practice, the error rate is fairly high throughout. About 1.7% of the strokes were in error for both subjects. Subject (JT) made a total of about 1000 errors and RB about 1600 errors on the random words.

An analysis of the errors made by RB disclosed that 26% of his errors involved pushing only one key of a two-key pattern, 22% of his errors were omissions of one or more letters in a word and 13% of his errors resulted from pressing the key under the finger which is used for that letter on the conventional typewriter keyboard. As might be expected, the experienced typist, JT, made more errors caused by using the finger appropriate on the conventional keyboard (23%). JT also made more errors involving pushing only one key of a two-key pattern (43%), but many fewer errors caused by omitting letters altogether (2%). Typing text showed even greater interference from the standard keyboard for the subject who typed regularly with a conventional typewriter (35% of his total errors), while this kind of error made up only 5% of the total errors for the other subject. Errors due to hitting only one key of a two-key pattern dropped markedly for both subjects when typing text (to 11% and 12% of the total errors) while errors of omission remained at roughly the same level (4% for JT and 23% for RB). Most of the errors of omission were due to a machine limitation which resulted in the complete loss of a key-pressing response which occurred too soon after the previous response. Of course, this limitation was more serious for the faster subject and led to a greater number of errors of apparent omission in his record.

## Discussion

The performance curves of Figure 2 provide some comparison between the ten-key typewriter and the conventional keyboard. The better subject, RB, reached a gross speed on text of 46 words per minute and the other subject a speed of 28 words per minute after a total exposure to the key-

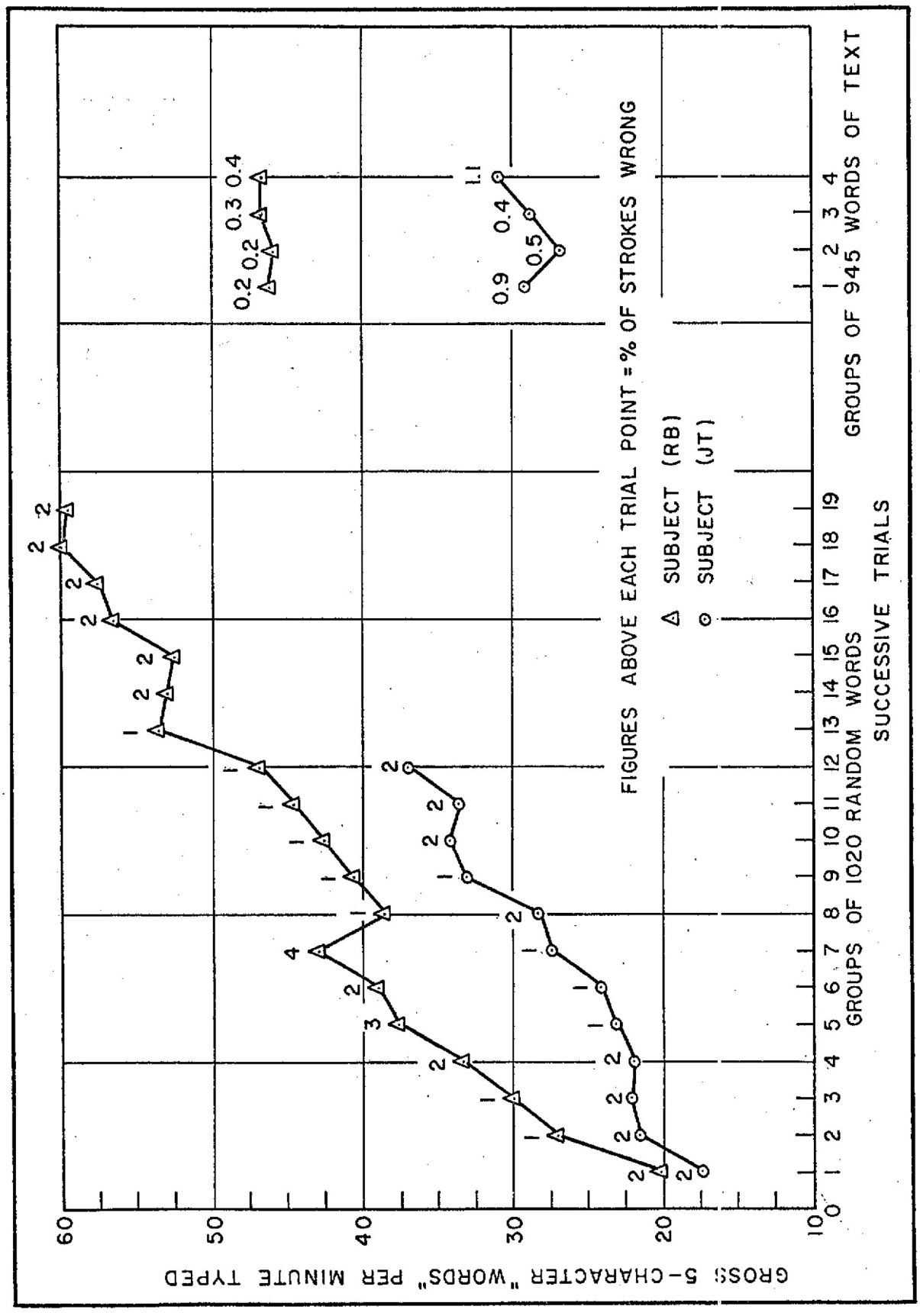


Figure 2 - Typing speed with a ten-key keyboard as a function of practice. Lower speed and fewer errors on text is the result of increased emphasis on accuracy.

board of less than 40 hours. Correcting for errors will lower these rates appreciably but, even so, the speeds obtained are not out of line with performance in learning to type on a conventional machine.

The analysis of errors provides encouraging information about multiple key-pressing. If the subjects had difficulty hitting two keys simultaneously many of the errors would be in the category of hitting only one key of a two-key pattern. The fact that this kind of error is only 11 - 12% of the total errors in typing text suggests that people are capable of pressing multiple keys almost simultaneously (within .03 sec.).

The large interference effect between the conventional typewriter and the ten-key keyboard could be reduced by changing the code on the ten-key machine to use the same single finger code as the standard key-board. Even if this were not possible, there is ample evidence that such "negative transfer" disappears with added practice.

Despite the encouraging results in learning to type with the ten-key typewriter, it is still the opinion of the author that the multiple-press keyboard will offer significant advantages over the conventional keyboard only when a large number of alternatives can be coded onto single key-press patterns.

## Conclusion

In view of the reasonable level of performances of two subjects in learning to type with the ten-key keyboard using an alphabetic code it is deemed advisable to continue the study of this keyboard using a code capable of typing whole words from a single press of particular combinations of keys. Learning time on a simulated word-writing typewriter with a vocabulary of up to 200 words is currently being studied. In addition, basic studies of the psychological factors involved in multiple key-pressing are in progress.